APPENDIX B

Pacific Halibut Discard Mortality Rates in the 1990-1999 Alaskan Groundfish Fisheries, with Recommendations for Monitoring in 2001 and Beyond

by

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Relative to the report presented in November, 1999, this document includes the following:
Analysis of data collected in 1999 from open access and CDQ vessels;

1) Calculated DMRs for 1999; and
2) Recommendations for DMRs in fisheries in 2001 and subsequent years.

Summary

Results from analysis of halibut release condition data for 1999 show continued stability in halibut discard mortality rates (DMRs) for many fisheries. Plots of annual DMRs against the 10-year mean indicated little change since 1990 for some fisheries, particularly the major trawl fisheries. DMRs were more variable for the smaller fisheries which typically take minor amounts of halibut bycatch. A new procedure for determining Preseason Assumed DMRs is proposed, which includes use of the long-term mean DMR for a 3-year period before revisions are proposed. IPHC will continue to conduct annual analyses of observer data and recommend changes to the Preseason Assumed DMR where a fishery DMR shows large variation from the mean.

Introduction

Pacific halibut discard mortality rates (DMRs) in the Alaskan groundfish fisheries are estimated from viability data collected by NMFS observers. Analysis by staff of the International Pacific Halibut Commission (IPHC) results in recommendations to the North Pacific Fishery Management Council (NPFMC) for managing halibut bycatch in the upcoming season. This paper describes the results from an analysis of data collected from the 1999 fishery and includes recommendations for Preseason Assumed DMRs for 2001 and beyond.

Data Used and Methods

Observer haul-by-haul data from the NMFS NORPAC data base were used for this analysis. The data records included the catch of groundfish by species or species group, estimates of the number and weight of halibut bycatch, and the number and length of halibut sampled for viability by category (excellent/poor/dead). Records for all hauls sampled by observers in 1999 were obtained and appended to data currently on hand for 1990-1998. Hauls not sampled for species composition were excluded.

The first task was to partition the records into target fishery categories, which was accomplished through a “retained catch” approach, using the catch composition for sampled hauls summed during a reporting week. The target is then assigned based on the percentage of particular species within the weekly catch composition (Williams 1997).

The targeting determination was based on a series of assumptions about the total catch and retained catch within a reporting week. Midwater pollock hauls were split out if that species comprised 95% of the total catch. A similar approach was used for an Arrowtooth flounder target in the Gulf of Alaska (GOA), but the assignment was made at 65% of the total catch. The determination for the remaining targets assumes that all arrowtooth flounder caught in a haul were discarded; the remaining species are assumed retained. Target determination was based on the species/species group comprising the greatest percentage of the "retained" catch. Flatfish targets in the Bering Sea/Aleutian Islands (BSAI) were determined in a succession of comparisons of individual flatfish species compositions in the catch. Table 1 shows the target codes and definitions used in this analysis.

The approach was modified slightly for Multispecies Community Development Quota (MSCDQ) fisheries. Because of the nature of the MSCDQ operations, vessels can potentially move from one target to another on every haul, rendering a "weekly" approach meaningless. So a target was assigned to each haul, using the same species composition criteria employed for open access fisheries.

NMFS observers examine halibut for the release viability upon return to the sea. Each fish is judged according to a set of criteria (Tables 2-4), which are used to determine internal and external injuries, and body damage from predators (e.g., sand fleas and others). Observers record the number of excellent, poor and dead condition halibut for each haul/set sampled. Viability samples are only collected on hauls sampled for species composition. The species composition sampling provides an estimate of the total number of halibut caught in the haul, as well as the catch of groundfish, necessary for determining the target. Observers are instructed to limit the number of fish examined to a maximum of 20, although this is occasionally exceeded by enthusiastic observers.

Next, the viability distribution is calculated. First, for each haul, the proportion of halibut in each category is extrapolated up to the total number of halibut caught. The extrapolated numbers of excellent, poor and dead halibut are then summed within each region/gear/target/vessel strata.

The general model for calculating the DMR for halibut caught by gear ***g*** is of the form:

$$DMR_g = \sum_{i=1}^{3}\left(m_{i,g} \times P_i\right)$$

where ***m*** is the mortality rate for gear ***g***, and ***P*** is the proportion of halibut in condition ***i***, where 1 is excellent, 2 is poor, and 3 is dead.

The mortality rate ***m*** varies among gear types (see Clark et al. 1992 for trawls, Williams 1996 for other gears) and represent the aggregate effects of external and internal injuries to the fish and the presence of predation by amphipods. There can be many sources of injuries, which vary by gear type. For longlines, injuries are most frequently caused by improper release methods practiced by vessel crews. Other significant factors include the length of the soak time, which can exacerbate the mortality caused by hooking injuries and also increase the potential for amphipod predation. Halibut mortality rates by gear and condition are shown in the following table:

Gear (g)	m_{exc}	m_{poor}	m_{dead}
Longline	0.035	0.518	1.00
Trawl	0.20	0.55	0.90
Pot	0.00	1.00	1.00

Mean fishery DMRs and associated standard errors were estimated by assuming that each vessel was a separate sampling unit, enabling a DMR to be calculated for each individual vessel in a target fishery. The DMR for a target fishery is then estimated as the mean of vessel DMRs, where the vessel's proportion of the total number of bycaught halibut is used as a weighting factor, as follows:

Let DMR_v = observed DMR on vessel $\boldsymbol{v}$

p_v = proportion of total number of halibut caught on vessel $\boldsymbol{v}$ in a fishery

Then $$\overline{DMR} = \sum_{v=1}^{n} \left(p_v \times DMR_v \right)$$

Standard errors of the weighted mean DMR were estimated as:

$$V\left(\overline{DMR}\right) = \sum_{v=1}^{n} \left(p_v^2 \times V\left(DMR_v\right) \right)$$

and $$SE\left(\overline{DMR}\right) = \sqrt{V\left(\overline{DMR}\right)}$$

where $V\left(DMR_v\right)$ is the sample variance of all the $DMRs_v$, and $V\left(\overline{DMR}\right)$ and $SE\left(\overline{DMR}\right)$ are the variance and standard error of $\overline{DMR}$, respectively.

Results for 1999

Open Access

Information on the number of vessels and hauls where halibut viability data were collected is summarized in Table 5. The three major BSAI trawl fisheries (bottom and midwater pollock, cod) had over 80 vessels with observers, with 1,000 hauls or more sampled in each fishery. The number of vessels observed in the four flatfish fisheries ranged from 21 to 29. The smaller trawl fisheries for atka mackerel and rockfish had 16 and 15 vessels observed, respectively. The pot fishery for cod had a greater number of vessels observed than the longline cod fishery (83 vs. 38).

In the GOA trawl fisheries, the number of vessels observed also varied considerably, with the midwater fishery for pollock the highest at 81 vessels. The number of observed vessels (60) was also quite high in the fishery for cod. Fewer vessels were observed in the bottom trawl pollock (44) and rockfish (44) fisheries. The flatfish targets (rex, flathead, deep and shallow water flats) had relatively few vessels observed, ranging from 7 to 13, suggesting fewer vessels were actually fishing for flatfish in 1999. Ten trawl vessels targeted Arrowtooth flounder, down slightly from 1998. As in the BSAI, the cod pot fishery had more vessels observed (44) than the longline fishery (16).

The rockfish longline targets had relatively few vessels observed, but this continues a pattern observed in most years. These fisheries are traditionally prosecuted by smaller vessels, i.e., vessels less than 60'. Observer coverage of these fisheries is usually dependant on a large observed vessel targeting on rockfish for a few hauls while actually conducting its primary fishing on other targets. The resulting coverage is sporadic at best and the amount of data collected minimal. At these levels, it is unlikely that the data compiled are representative of the overall fishery.

The number of halibut examined by observers in a single fishery was, in most cases, substantial: e.g., over 13,000 fish in the BSAI cod trawl fishery and more than 21,000 fish in the BSAI cod hook-&-line fishery (Table 5). Seven of ten BSAI trawl fisheries had sample sizes greater than 1,000 fish. In contrast, hook-&-line fisheries other than cod had very few halibut sampled. The GOA fishery with the largest number of halibut examined was trawl cod (over 6,000 fish). Trawl rockfish and rex sole had roughly 1,700 and 1,000 halibut examined. All other GOA fisheries had less than 1,000 fish examined, and all but two had less than 300 halibut examined.

A summary of the number of actual observations and the extrapolated number of halibut for the 1999 open access fisheries is in Table 6. In addition, the estimated DMR and its standard error is reported for each fishery. The entire historical set of DMRs and standard errors by year, area, gear, and target fishery are shown in Figures 1-3.

In general, the DMRs calculated in this analysis were consistent with past analyses. Trawl fishery DMRs ranged from 0.50 to 0.90, with DMRs generally higher in the BSAI. Longline fishery DMRs ranged from 0.12 to 0.17. Pot fisheries for cod had lower DMRs than longline or trawl in each area, and were lower in the BSAI than in the GOA.

In general, BSAI trawl fishery DMRs exhibited no overall increase or decrease; results were mixed when compared to 1998 estimates. For the BSAI, decreases were noted for bottom trawl pollock (0.80 in 1998 to 0.74 in 1999), other flatfish (0.78 to 0.63), turbot (0.86 to 0.70), and yellowfin sole (0.82 to 0.78). All others increased or were unchanged. However, in the GOA, a majority of trawl targets had higher DMRs in 1999. Only the cod fishery declined (from 0.64 to 0.54) and two others were unchanged.

For longline targets, the BSAI cod fishery DMR remained essentially unchanged while the GOA fishery increased markedly. Since 1996 the BSAI fishery for cod has maintained its DMR at 0.11-0.12 and the 1999 fishery continued this trend. During this same period, the GOA fishery has ranged from 0.11 to 0.22; the 1999 value is the second highest since 1991 and above the 10-year mean DMR of 0.14. An increase in the number of vessels (from 9 to 15) may have affected these results, particularly if vessel crews were inexperienced at carefully releasing bycaught halibut.

Pot fishery DMRs decreased in both areas in 1999, from 0.13 to 0.09 in the BSAI and from 0.16 to 0.13 in the GOA. Estimates of the standard errors (Figure 3) suggests that the decreases are not statistically significant, however. The 1999 values are very similar to the 10-year mean DMRs.

Flathead Sole Fishery

GOA trawl industry representatives requested an analysis of DMRs by processing sector in the shallow water trawl fishery for flathead sole. The hypothesis is that the catcher/processor fleet has a higher DMR than the catcher vessel fleet that delivers shoreside. The data for this fishery for 1995-1999 were aggregated by sector and are reported in Table 7.

Vessel effort has been relatively low in this fishery, i.e., less than 8 vessels from either sector have participated in any given year. All vessels in the fishery carried observers, although only one vessel (a catcher/processor) was large enough to require 100% observer coverage. In 1999, fishing took place in February and April. Only two catcher/processors and 4 catcher vessels participated in 1999.

Williams and Hare (2000) analyzed data from 1995-1998 for differences in halibut DMRs between sectors. They found that, although the catcher vessel fleet has had lower DMRs than the catcher/processor fleet during 1995-1998, sufficient variability exists both between sectors and among vessels within each sector that there is little statistical difference in DMRs between the sectors. However, differences are difficult to detect in fisheries with a small number of vessels, such as flathead sole, so the possibility of differences in DMRs between catcher/processors and catcher vessels cannot be ruled out.

The addition of data from 1999 adds little to further justify sector-specific DMRs. No viability data were collected on either of the catcher/processors in 1999, leaving data from the four catcher vessels as the only source of information about the 1999 fishery. A total of 102 halibut from three hauls were examined, providing a DMR of 0.51.

MSCDQ Fisheries

A summary of observer coverage, sampling, and halibut viability data is shown in Table 8. In 1999 only trawl and longline gear was used in CDQ fishing. Applying the target algorithm on the haul species composition resulted in hauls being identified for all possible targets. However, the majority of data was collected on trawl hauls targeting pelagic and bottom pollock and longline sets targeting cod.

For the bottom and pelagic pollock trawl targets, almost all halibut were dead when sampled by the observer. The large proportion of dead halibut is very similar what is found in the open access pelagic pollock fishery, but is much higher than the open access bottom pollock fishery. This difference is less of a reflection of different fishery practices but more an artifact of the targeting determination, where hauls with >95% pollock are assigned as a pelagic target; less than 95% would fall into the bottom pollock target. In reality, most of the hauls in the CDQ bottom pollock target were comprised of at least 75% pollock and are likely being fished midwater and not on the bottom as in the open access fishery. Data on CDQ halibut viability resulted in similar DMRs for both pelagic (0.90) and bottom pollock (0.88) fisheries. Despite these high DMRs, it is important to remember that halibut bycatch is extremely low in pollock fisheries, the result of low bycatch rates.

For other trawl targets, with the exceptions of other flatfish and flathead sole, all targets fell into the range of 0.80-0.90.

Longline CDQ fishing in 1999 consisted primarily of cod fishing, with minor amounts of effort directed towards turbot, sablefish, and rockfish. Very little viability data were collected from the non-cod targets.

Distribution of halibut viability in the CDQ cod fishery was slightly better than that observed in the open access cod fishery, resulting in a lower DMR for the CDQ fishery (0.096 vs. 0.113). Standard error estimates indicated no statistically significant difference, however.

Sablefish IFQ Fishery

Analysis of IFQ fishery data has been complicated by two serious problems: (1) the inability to determine if an IFQ set was either a directed halibut or groundfish set, based on the data recorded by an observer, and (2) if halibut were retained, the inability to determine how much halibut was discarded for proper extrapolation of viability data. For all other fisheries, the inherent assumption is that all halibut are discarded; the DMR model is based on that assumption. The IFQ fishery violates that assumption, in that not only can a vessel retain both sablefish and halibut (assuming the operator possesses quota shares), but vessels targeting cod, rockfish, or turbot may carry IFQ to enable retention of any bycatch of legal-size halibut.

Observers are instructed to only take viability samples from halibut discarded from IFQ sets. To estimate a DMR, the viability sample is extrapolated to the total number of halibut discarded. However, only the total catch of halibut is recorded and not the amount retained or discarded.

IPHC and North Pacific Groundfish Observer Program (NPGOP) staff have been working on solutions to these problems. In the interim, we propose using a DMR of 0.23 to estimate mortality in the IFQ fishery, based on an average of the 1990-1994 BSAI and GOA sablefish fishery DMRs. This DMR value is somewhat high, but represents a conservative approach relative to the DMRs estimated for most other hook & line fisheries, which have been generally less than 0.18 since the IFQ program began in 1995.

Recommendations for Preseason Assumed DMRs for 2001 and Beyond

The results from this analysis are used to determine Preseason Assumed DMRs for in-season management of halibut bycatch by NMFS. This is done because the data collected each year are not available for analysis until well after the conclusion of most fisheries, usually not until the following year. Since 1993, Preseason Assumed DMRs were adopted for an upcoming season based on trends in DMR data from prior years. This year we are proposing a new approach, detailed below, for the open access fisheries.

Open Access Fisheries

One characteristic noted in halibut DMRs is the relative stability exhibited in most fisheries since 1990. In many fisheries DMRs have varied very little from the long-term average. Examples of this include the GOA trawl fisheries for cod and shallow water flatfish (Figure 1), the BSAI trawl fisheries for cod, bottom and pelagic pollock, and yellowfin sole (Figure 2), the BSAI and GOA pot fisheries for cod (Figure 3), and the GOA hook-&-line fishery for cod (Figure 3).

On the other hand, fishery DMRs have shown a response when specific management measures have been imposed directed at reducing mortality. The BSAI hook-&-line fishery for cod has shown the most improvement in this area, declining from 0.23 in 1991 to 0.11-0.12 since 1996. But without regulations to influence handling or fishing practices, DMRs in general have shown little change, particularly in recent years.

A few fisheries have exhibited large annual variability in DMRs, but these are generally fisheries with small groundfish TACs or with fleets comprised of smaller vessels that results in sporadic observer coverage and resulting data. The hook-&-line fisheries for rockfish are one example. Typically, halibut bycatch in these fisheries is a small fraction of the overall amount of bycatch taken by the respective gear type.

This year we propose using the long-term average for Preseason Assumed DMRs, rather an average of the two preceding years as has been past practice. A second part of this proposal is to discontinue the annual specification and adoption of Preseason Assumed DMRs. Instead, these long-term averages would be used for a period of 3 years before changes are proposed, or following the implementation of management programs which would affect the DMRs, such as the Halibut Mortality Avoidance Program (HMAP) proposed by the industry.

We find that the proposed approach has several potential benefits. With the DMRs set for a 3-year period, industry will have the opportunity to better plan the allocation of bycatch among fisheries. In addition, we believe this will shift the focus from reducing mortality through lower DMRs to reducing bycatch. The overall stability of DMRs in recent years suggests that the industry may have reduced mortality as far as is practical or economical within the existing management system. Reduction of actual bycatch has not been a subject of much discussion for some time but may become a concern should the groundfish fishery be restructured as a consequence of imposition of other management issues.

NMFS manages halibut bycatch such that each fishery operates within its bycatch mortality limit; the fishery is closed when the limit is reached. The absence of real-time DMR data from each fishery means using data from prior years as a proxy. As such, the goal is to use a set of DMRs to calculate an estimate of bycatch mortality that is the best approximation of the actual bycatch mortality that is estimated using the data collected from the fishery.

To determine if the use of a long-term average DMR results in a more accurate estimate of the actual bycatch mortality, we compared the bycatch estimates resulting from a set of Preseason Assumed DMRs to the bycatch estimated using a set of long-term DMRs. We used the estimates of the actual bycatch mortality, based on the real-time fishery data, as the basis for the comparison. Using data from 1995-1999, we next calculated the bycatch for each target fishery using the 10-year average DMR and the Preseason Assumed DMR adopted for that fishery in that year. The ratio of estimated bycatch to actual bycatch was next calculated as:

$$R_{P,A} = \frac{Bycatch_p}{Bycatch_A} \quad and \quad R_{L,A} = \frac{Bycatch_L}{Bycatch_A}$$

where P = preseason assumed DMRs, L = long-term DMRs, and A = actual DMRs.

A ratio of 1.0 would indicate that either set of DMRs estimates bycatch as accurately as the actual DMRs in the fishery that year. A value of R less than 1.0 indicates that the preseason (or long-term) DMR underestimated the actual DMR, while a value greater than 1.0 indicates the opposite occurred.

The ratios for each fishery during 1995-1999 are plotted in Figure 4. The ratios were widely scattered both above and below 1.0 at a bycatch mortality of 500 mt or less, but as bycatch mortality increases the spread became much tighter around 1.0. From the data shown in Figure 4 it is difficult to determine which method performs better, so we calculated the mean ratio for each method in bycatch mortality strata of <500 mt, 500-1,000 mt, and >1,000 mt. These results, shown in Figure 5, indicate that while both the preseason assumed DMR method and the long-term average DMR method underestimate the actual bycatch mortality in fisheries with less than 1,000 mt of bycatch, the long-term method comes closer to the actual bycatch mortality. The same appears to be true when bycatch mortality is greater then 1,000 mt, but in this case both methods tend to result in overestimates of the actual bycatch mortality. Overall, the long-term average DMR approach tends to result in estimates of bycatch mortality closer to the actual determined using actual fishery data.

For this reason, we are recommending a set of DMRs for 2001-2003 which is based on data collected during 1990-1999 for all but one fishery. As noted earlier, the BSAI hook-&-line fishery was successful in reducing its DMRs through the Careful Release regulation. Since 1996 their DMR has remained essentially unchanged at the 0.11-0.12 level. Consequently we are recommending 0.12 for this fishery, instead of the 10-year average of 0.16. The entire set of recommended DMRs is shown in Tables 9 and 10.

Recommendations are also provided for the ‘other species’ target. The analysis did not identify any hauls as an ‘other species’ target, so the recommendations shown are based on the recommendations for the gear/target fishery in each region that takes the predominant amount of bycatch. In the BSAI and GOA, these are the fisheries for Pacific cod.

GOA Trawl Flathead Sole

Last year's analysis (Williams and Hare 2000) indicated that, while the estimated DMRs have been consistently lower during 1995-1998 for the catcher vessel fleet, the variability is too great within 1998 and also among years to be able to detect statistically significant differences between sectors. The inclusion of 1999 data added virtually nothing to the analysis, as even less data were collected in 1999 than in previous years. Therefore, we again recommend a single DMR for this fishery as was done last year.

MSCDQ Fisheries

As in 1998, MSCDQ trawl effort in 1999 was focused primarily on pollock; effort at other targets was apparently very low, as too few halibut were examined in all but a few fisheries. We recommend that the 2001 MSCDQ fisheries use the 1999 MSCDQ DMRs shown in Table 9, with the remaining targets using the open access recommendations found in Table 9.

MSCDQ longline fishing in 1999 was directed primarily at cod and resulted in a DMR of 0.10 (Table 9). We recommend that this DMR be used in 2001. As with trawls, too few halibut were examined to provide meaningful results for other longline targets. Other longline and pot targets should use the open access DMRs recommended in Table 9.

Sablefish IFQ Fishery

Data collection and analysis of sablefish IFQ sets is problematical because of the data problems outlined earlier. For this reason, we are recommending using an assumed DMR of 0.23 for calculating mortality until such time that appropriate data are collected and analyzed.

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Table 1. 1999 groundfish target definitions and target determination method used to classify NORPAC hauls in the halibut viability and discard mortality rate analysis.

BSAI Target	Definition	GOA Target	Definition
A	Atka mackerel	A	Atka mackerel
B	Bottom pollock	B	Bottom pollock
C	Pacific cod	C	Pacific cod
F	Other flatfish	D	Deep water flatfish
K	Rockfish	H	Shallow water flatfish
L	Flathead sole	K	Rockfish
O	Other spp.	L	Flathead sole
P	Pelagic pollock	O	Other spp.
R	Rock sole	P	Pelagic pollock
S	Sablefish	S	Sablefish
T	Greenland turbot	W	Arrowtooth flounder
Y	Yellowfin sole	X	Rex sole
Z	No retained catch		

OPEN ACCESS and CDQ TARGET DETERMINATION

Retained Catch = Total Groundfish Catch **-** Arrowtooth Flounder

Bering Sea/Aleutians

P if Pollock ≥ 95% of total groundfish catch, or

Y/R/L/F if (rock sole + other flatfish + yellowfin sole + flathead) is the largest component of the retained catch using this rule:

- **Y** if yellowfin sole is ≥ 70% of (rock sole+other flatfish+yellowfin sole+flathead sole), or
- **R** if rock sole > other flatfish and rock sole > flathead sole, or
- **L** if flathead sole > other flatfish and flathead sole > rock sole, or
- **F** if none of the three conditions above are met.

If target is not P, Y, R, L or F, then target is whichever species or species group (A, B, C, K, O, S, T) forms the largest part of the **retained catch**.

Gulf of Alaska

P if Pollock ≥ 95% of total groundfish catch, or

W if Arrowtooth flounder ≥ 65% of total groundfish catch.

If target is not P or W, then target is whichever species or species group (A, B, C, D, H, K, L, O, S, X) forms the largest part of the **retained catch**.

Table 2. Definition of Pacific halibut discard condition codes for trawl gear in 1999.

EXCELLENT**:** No sign of stress

- Injuries, if any, are minor, limited to superficial nicks or cuts on body. Minor fin fraying. Hemorrhaging of skin on white side limited to 5-10% of surface area.
- Fish closes operculum (gill cover) tightly for at least 5-10 seconds.
- Muscle tone or physical activity is strong. Jaw may be tightly clenched.
- No bleeding observed.
- Gills are deep red in color, indicating no loss of blood.

POOR: Alive, but showing signs of stress

- Moderate injuries may be present. Moderate severity to any abrasions or cuts that may be present. Severe fin fraying. Slight bleeding from fin edges. Approximately 25% of skin on white side of fish shows hemorrhaging.
- Fish closes operculum weakly and not sustained.
- Muscle tone or physical activity is weak. Intermittent movement. May respond if stimulated. Body appears limp.
- Bleeding from gill area may be occurring, but not profusely.
- Gills are deep to bright red, indicating some loss of blood.

DEAD: No sign of life or, if alive, likely to die from severe injuries or suffocation

- Vital internal organs may be damaged. Body or body cavity may be ripped open. Severe skin lacerations. Sediment in mouth. Hemorrhaging in skin on 50% or more of white side.
- Fish does not close operculum, jaw may be open.
- No sign of muscle tone. Physical activity absent or limited to fin ripples or twitches. Little, if any, response to stimuli.
- Severe bleeding may be occurring from gill area.
- Gills appear washed out, e.g., dull red, pink, or white in color, indicating a substantial loss of blood.

Table 3. Definition of Pacific halibut discard condition codes for hook and line gear in 1999.

EXCELLENT: No sign of stress

- Hook injuries are minor (limited to the hook entrance/exit hole, torn lip) and located in the jaw or cheek. Jaw is in one piece, not split or separated from head. Eye socket may be torn, but eyeball is undamaged.
- Vital internal organs are undamaged.
- Bleeding, if present, is minor and limited to jaw area.
- No penetration of the body by sand fleas, even though they may be present in small numbers on body surface. No external damage to fins or skin by sand fleas.
- Muscle tone or physical activity is strong.
- Gills are deep red in color, indicating no loss of blood.

POOR: Alive but showing signs of stress

- Hook injuries to jaw are minor to moderate. Lower jaw may be split at snout (i.e., the anterior point), but all jaw parts are present. Or, one side of the upper or lower jaw may be separated from the head at the hinge, but still remains. Eyeball is punctured, but eye socket may or may not be torn. Rest of head is undamaged.
- Vital internal organs are not injured.
- Bleeding may be light to moderate, but not from gills.
- Sand fleas may be present on body, but no penetration of the eyes, fins, anus is noticed. Any damage is limited to small marks on skin or near fins.
- Muscle tone or physical movement may be weak or intermittent; little, if any, response to stimuli.
- Gills are deep to bright red, indicating some loss of blood.

DEAD: No signs of life or, if alive, likely to dies from severe injuries

- Severe injuries to jaw and/or head. Gills may be torn. Gaff wound to head or body. Side of face or part of the head may be missing or only loosely attached. Either a portion of the lower jaw is missing or the entire lower jaw is completely missing.
- Vital internal organs may be damaged. A jig-hook injury to viscera may have occurred.
- Sand fleas have penetrated the body (they usually attack the eyes first, but also fins and anus). This may be very noticeable, but closely examine the fish. Other predators may have damaged the fish, including sea lions and orca whales, which will take an obvious bit out of the fish, to lampreys, which leave a hole in the side of the fish.
- Severe bleeding may occur, especially from the gills.
- No sign of muscle tone. Physical activity absent or limited to fin ripples or twitches.
- Gills appear washed out, e.g., dull red, pink, or white in color, indicating a substantial loss of blood.

Table 4. Definition of Pacific halibut discard condition codes for pot gear in 1999.

EXCELLENT: No sign of stress

- ♦ Injuries, if any, are minor. Hemorrhaging of skin on white side limited to 5-10% of surface area.
- ♦ Fish closes operculum (gill cover) tightly for at least 5-10 seconds.
- ♦ Muscle tone or physical activity is strong. Jaw may be tightly clenched, very difficult to open.
- ♦ Minor fin fraying, but no bleeding. Superficial nicks or cuts, perhaps from crabs in the pot or from the pot itself, but no bleeding.
- ♦ No penetration of the body by sand fleas, even though they may be present in small numbers on body surface. No external damage to fins or skin by sand fleas.
- ♦ Gills are deep red in color, indicating no loss of blood.

POOR: Alive, but showing signs of stress

- ♦ Moderate injuries may be present. Approximately 25% of skin on white side of fish shows hemorrhaging. Severe fin fraying.
- ♦ Fish closes operculum weakly and not sustained.
- ♦ Muscle tone or physical activity is weak. Intermittent body movement. May respond if stimulated. Body appears limp.
- ♦ Slight bleeding from fin edges or body. Moderate abrasions or cuts, perhaps from crabs in the pot or from the pot itself.
- ♦ Sand fleas may be present on body, but no penetration of the eyes, fins, anus is noticed. Any damage is limited to small marks on skin or near fins.
- ♦ Gills are deep to bright red, indicating some loss of blood.

DEAD: No sign of life or, if alive, likely to dies from severe injuries

- ♦ Vital internal organs may be damaged. Body tissue or body cavity may be ripped open. Hemorrhaging in skin on 50% or more of white side.
- ♦ Fish does not close operculum. Jaw may be open and slack.
- ♦ No sign of muscle tone. Physical activity absent or limited to fin ripples or twitches. Little, if any, response to stimuli.
- ♦ Severe bleeding may be occurring from fin edges or body. Severe abrasions or cuts, some of which may penetrate the body cavity. Severe skin lacerations.
- ♦ Sand fleas have penetrated the body (they usually attack the eyes first, but also fins and anus). This may be very noticeable, but closely examine the fish. Crabs in the pot may also have attacked and eaten the "dead" fish.
- ♦ Gills appear washed out, e.g., dull red, pink, or white in color, indicating a substantial loss of blood.

Table 5. **Information on observer coverage, sampling, and size composition of the halibut bycatch in 1999.**

Gear and Target	No. of Vessels Observed	No. of Hauls Sampled	No. of Fish Measured	Extrap. # of fish	Mean Lgth. (cm)	Percent <65 cm	Percent <82 cm
BSAI Trawl							
Atka mackerel	16	989	424	14,034	66.8	53.9	81.4
Bottom pollock	93	1,674	4,935	177,050	47.4	91.3	96.7
Pacific cod	84	2,310	13,711	377,305	47.3	94.3	98.6
Other Flatfish	25	725	1,370	48,133	59.7	63.1	84.8
Rockfish	15	222	136	5,849	67.3	69.1	81.4
Flathead sole	21	1,144	3,192	97,707	60.6	69.5	90.7
Pelagic pollock	94	8,117	7,678	18,081	53.3	83.9	93.0
Rock sole	25	1,280	6,870	410,510	43.1	93.7	96.9
Turbot	11	114	95	2,177	71.0	41.7	70.6
Yellowfin sole	29	1,589	1,651	43,542	67.9	50.3	69.1
BSAI Pot							
Pacific cod	83	1,690	1,432	2,567	71.8	22.4	84.9
BSAI Longline							
Pacific cod	38	5,881	21,530	312,265	69.4	42.2	79.4
Rockfish	3	5	0	0	-	-	-
Turbot	17	256	50	592	92.7	0.2	3.3
GOA Trawl							
Atka mackerel	0	0	0	0	-	-	-
Bottom pollock	44	193	669	5,665	64.4	50.7	85.2
Pacific cod	60	826	6,048	74,545	60.5	64.7	94.3
Dp wtr. flatfish	12	82	228	3,893	87.3	6.0	47.0
Shall wtr. flatfish	13	66	552	13,189	53.6	78.8	92.8
Rockfish	44	629	1,696	23,193	84.5	21.4	47.5
Flathead sole	7	19	22	102	106.6	2.9	3.9
Pelagic pollock	81	704	282	324	66.3	45.2	73.5
Arrowtooth flndr	10	52	120	3,630	70.2	30.4	84.4
Rex sole	9	380	1,005	20,751	69.0	34.6	87.6
GOA Pot							
Pacific cod	44	671	3,690	11,473	80.0	5.3	60.6
GOA Longline							
Pacific cod	16	200	1,202	37,916	74.8	20.2	72.4
Rockfish	1	3	0	0	-	-	-

Table 6. Distribution of halibut viability data by condition factor and target fishery during 1999.

	Raw Data				Extrapolated Data				
Target	**Exc.**	**Poor**	**Dead**	**DMR**	**Exc.**	**Poor**	**Dead**	**DMR**	**SE**
BSAI Trawl									
Atka mackerel	32	57	316	**0.80**	973	1,818	11,061	**0.81**	**0.043**
Bottom pollock	758	465	3,344	**0.75**	28,308	17,890	113,425	**0.74**	**0.054**
Pacific cod	2,664	2,443	6,573	**0.67**	71,495	55,761	183,626	**0.69**	**0.040**
Other flatfish	263	243	404	**0.60**	5,910	4,079	12,467	**0.63**	**0.088**
Rockfish	46	22	67	**0.60**	557	394	4,889	**0.81**	**0.124**
Flathead sole	252	536	2,188	**0.78**	6,579	13,343	72,255	**0.79**	**0.068**
Pelagic pollock	116	307	6,785	**0.87**	256	974	15,405	**0.87**	**0.015**
Rock sole	834	592	4,835	**0.77**	37,085	22,604	329,861	**0.81**	**0.031**
Sablefish	0	2	13	**0.85**	0	2	1,601	**0.90**	**0.123**
Turbot	23	17	40	**0.62**	414	289	1,269	**0.70**	**0.090**
Yellowfin sole	236	197	1,127	**0.75**	4,919	4,012	30,938	**0.78**	**0.050**
BSAI Pot									
Pacific cod	1,278	66	77	**0.10**	2,324	96	136	**0.09**	**0.051**
BSAI Longline									
Pacific cod	12,086	1,604	403	**0.12**	179,407	24,828	5,909	**0.12**	**0.020**
Rockfish	0	0	0	**--**	0	0	0	**--**	**--**
Turbot	15	5	0	**0.16**	314	124	0	**0.17**	**0.118**
GOA Trawl									
Bottom pollock	178	98	183	**0.55**	1,644	1,689	1,697	**0.55**	**0.109**
Pacific cod	2,299	1,501	1,943	**0.53**	30,449	13,525	28,557	**0.54**	**0.058**
Dpwtr flatfish	115	67	38	**0.43**	1,668	964	1,217	**0.51**	**0.100**
Shwtr. flatfish	33	59	360	**0.80**	847	1,287	8,986	**0.81**	**0.023**
Rockfish	287	372	1,015	**0.70**	2,938	4,132	14,417	**0.74**	**0.070**
Flathead sole	11	8	3	**0.42**	16	83	3	**0.51**	**0.117**
Pelagic pollock	14	9	256	**0.85**	16	10	296	**0.86**	**0.054**
Sablefish	6	6	12	**0.64**	170	362	551	**0.67**	**0.102**
Arrowtooth flndr	19	13	62	**0.71**	628	365	2,398	**0.73**	**0.133**
Rex sole	180	128	429	**0.67**	3,698	2,051	10,941	**0.70**	**0.107**
GOA Pot									
Pacific cod	3,403	171	116	**0.08**	9,987	922	564	**0.13**	**0.089**
GOA Longline									
Pacific cod	979	126	54	**0.13**	25,302	5,803	1,794	**0.17**	**0.055**
Rockfish	0	0	0	**--**	0	0	0	**--**	**--**

Table 7. Sampling information and halibut viability data from 1995-1999 GOA trawl fishery for flathead sole.

Year	No. of Vessels	# hauls w/ hbt	# hauls w/ L/V data	No. of Halibut	% Exc.	% Poor	% Dead	DMR	SE
CATCHER/PROCESSORS									
1995	4	13	13	570	0.0	9.4	90.6	**0.873**	**0.017**
1996	5	33	33	1,986	16.0	54.9	29.0	**0.682**	**0.095**
1997	4	60	60	7,968	1.7	12.8	85.5	**0.791**	**0.161**
1998	3	45	20	1,073	57.3	9.0	33.7	**0.467**	**0.151**
1999	2	4	0	0	--	--	--	**--**	**--**
1995-98 Mean		-	-	-	-	-	-	**0.703**	**0.088**
1997-98 Mean		-	-	-	-	-	-	**0.629**	**-**
CATCHER VESSELS									
1995	6	23	23	732	33.2	30.7	36.2	**0.495**	**0.102**
1996	3	11	11	150	18.2	60.4	21.4	**0.568**	**0.193**
1997	7	33	33	1,014	21.8	49.9	28.3	**0.594**	**0.101**
1998	6	51	43	1,386	75.5	11.7	12.8	**0.331**	**0.099**
1999	4	6	3	102	15.7	81.4	2.9	**0.505**	**0.117**
1995-98 Mean		-	-	-	-	-	-	**0.497**	**0.059**
1997-98 Mean		-	-	-	-	-	-	**0.463**	**-**

Table 8. Observer coverage, sampling, and halibut viability data on 1999 Bering Sea/Aleutian MSCDQ hauls.

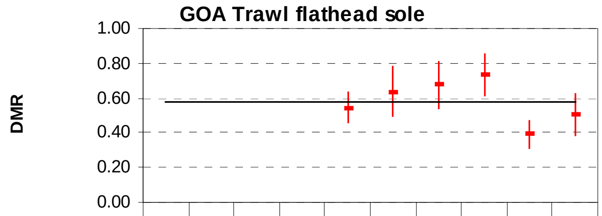
Gear & Fishery	# Vsls Observed	# Hauls Observed	# Hauls with hbt	# Vsls. w/ L/V samples	# Hauls w/ L/V samples	Raw Data Exc	Raw Data Poor	Raw Data Dead	Raw Data DMR	Extrapolated Data Exc	Extrapolated Data Poor	Extrapolated Data Dead	Extrapolated Data DMR	SE
CDQ Trawl														
Atka mackerel	4	101	74	4	57	8	6	223	**0.868**	29	85	508	**0.820**	**0.057**
BT pollock	28	208	80	19	58	0	7	148	**0.884**	0	93	1,982	**0.884**	**0.006**
Pacific cod	6	61	51	4	22	16	23	42	**0.662**	71	75	656	**0.805**	**0.120**
Other Flats	5	33	30	3	13	7	25	38	**0.705**	143	924	466	**0.624**	**0.114**
Rockfish	3	38	22	2	15	1	3	98	**0.883**	2	5	141	**0.879**	**0.015**
Flathead sole	3	69	38	2	35	16	15	41	**0.672**	493	687	1,774	**0.702**	**0.109**
Pelagic pollock	28	1,203	272	18	267	1	2	886	**0.898**	1	7	2,640	**0.899**	**0.001**
Rocksole	3	43	35	3	15	1	4	28	**0.836**	12	49	868	**0.872**	**0.099**
Turbot	3	18	14	1	1	0	0	1	**0.900**	0	0	31	**0.900**	**---**
Yellowfin sole	2	120	91	2	83	14	59	316	**0.822**	220	995	5,467	**0.825**	**0.172**
CDQ Longline														
Pacific cod	16	1,757	1,719	15	892	4,858	409	99	**0.090**	88,147	9,165	1,695	**0.096**	**0.019**
Rockfish	5	18	15	1	1	0	0	1	**1.000**	0	0	464	**1.000**	**---**
Sablefish	8	122	52	1	4	0	5	1	**0.598**	0	60	3	**0.540**	**---**
Turbot	6	61	24	5	10	23	1	2	**0.128**	870	2	248	**0.250**	**0.160**

Table 9. Summary of halibut discard mortality rates (DMRs) in the Bering Sea/Aleutian Islands (BSAI) groundfish fisheries during 1990-1999 and recommendations for Preseason Assumed DMRs in monitoring halibut bycatch mortality in 2001-2003 for the open access fisheries and in the 2001 CDQ fisheries.

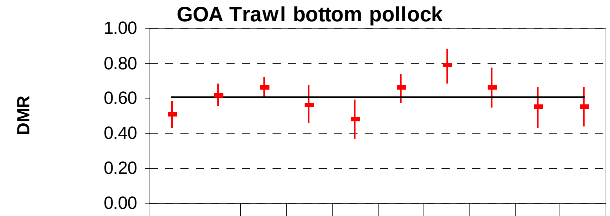
Gear/Target	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	Long-Term Mean DMR	Basis
Trawl												
Atka mackerel	66	77	71	69	73	73	83	85	77	81	75	1990-1999
Bottom pollock	68	74	78	78	80	73	79	72	80	74	76	1990-1999
Pacific cod	68	64	69	67	64	71	70	67	66	69	67	1990-1999
Other Flatfish	80	75	76	69	61	68	67	71	78	63	71	1990-1999
Rockfish	65	67	69	69	75	68	72	71	56	81	69	1990-1999
Flathead sole	-	-	-	-	67	62	66	57	70	79	67	1994-1999
Other species	-	-	-	-	-	-	-	-	-	-	67	Pcod fishery
Pelagic pollock	85	82	85	85	80	79	83	87	86	87	84	1990-1999
Rock sole	64	79	78	76	76	73	74	77	79	81	76	1990-1999
Sablefish	46	66	-	26	20	-	-	-	-	90	50	1990-1999
Turbot	69	55	-	-	58	75	70	75	86	70	70	1990-1999
Yellowfin sole	83	88	83	80	81	77	76	80	82	78	81	1990-1999
Pot												
Pacific cod	12	4	12	4	10	10	7	4	13	9	8	1990-1999
Other species	-	-	-	-	-	-	-	-	-	-	8	Pcod fishery
Longline												
Pacific cod	19	23	21	17	15	14	12	11	11	12	12	1996-1999
Rockfish	17	55	-	6	23	-	20	4	52	-	25	1990-1998
Other species	-	-	-	-	-	-	-	-	-	-	12	Pcod fishery
Sablefish	14	32	14	13	38	-	-	-	-	-	22	1990-1994
Turbot	15	30	11	10	14	9	15	22	18	17	18	1990-1999
CDQ Trawl												
Atka mackerel	-	-	-	-	-	-	-	-	-	82	82	Latest year
Bottom pollock	-	-	-	-	-	-	-	-	90	88	88	Latest year
Pelagic pollock	-	-	-	-	-	-	-	-	90	90	90	Latest year
Rockfish	-	-	-	-	-	-	-	-	-	88	88	Latest year
Yellowfin sole	-	-	-	-	-	-	-	-	-	83	83	Latest year
CDQ Longline												
Pacific cod	-	-	-	-	-	-	-	-	10	10	10	Latest year

Table 10. Summary of halibut discard mortality rates (DMRs) in the Gulf of Alaska (GOA) groundfish fisheries during 1990-1999 and recommendations for Preseason Assumed DMRs in monitoring halibut bycatch mortality in 2001-2003.

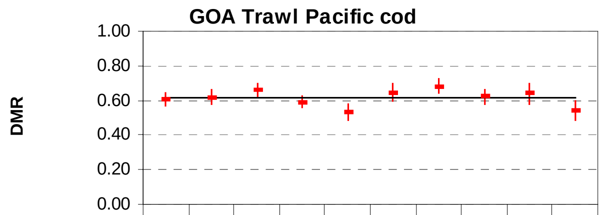
Gear and Target	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	Long Term Mean DMR	Basis
Trawl												
Atka mackerel	67	89	81	67	53	-	60	-	-	-	70	1990-1996
Bottom pollock	51	62	66	57	48	66	79	66	55	55	61	1990-1999
Pacific cod	60	62	66	59	53	64	70	62	64	54	61	1990-1999
Deep wtr flats	61	58	70	59	60	56	71	61	51	51	60	1990-1999
Shallow wtr flats	66	71	69	65	62	70	71	71	67	81	69	1990-1999
Rockfish	65	75	79	75	58	71	65	63	68	74	69	1990-1999
Flathead sole	-	-	-	-	54	64	67	74	39	51	58	1994-1999
Other species	-	-	-	-	-	-	-	-	-	-	61	Pcod fishery
Pelagic pollock	71	82	72	63	61	51	81	70	80	86	72	1990-1999
Sablefish	70	60	68	59	67	58	80	61	-	68	66	1990-1999
Arrowtooth fldr	-	-	-	-	-	-	66	48	62	73	62	1996-1999
Rex sole	-	-	-	-	56	76	63	47	58	70	61	1994-1999
Pot												
Pacific cod	12	7	16	24	17	21	7	11	16	13	14	1990-1999
Other species	-	-	-	-	-	-	-	-	-	-	14	Pcod fishery
Longline												
Pacific cod	15	18	13	7	11	13	11	22	11	17	14	1990-1999
Rockfish	6	-	-	7	-	4	13	-	9	-	8	1990-1998
Other species	-	-	-	-	-	-	-	-	-	-	14	Pcod fishery
Sablefish	17	27	28	30	22	-	-	-	-	-	24	1990-1994



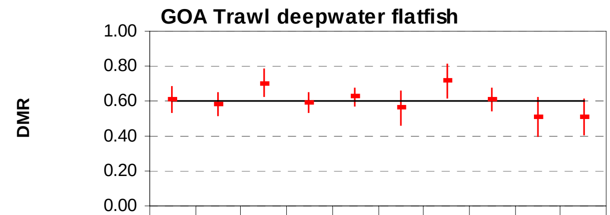
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
No. vessels					9	10	8	11	9	4
Annual DMR					0.54	0.64	0.68	0.74	0.39	0.51
10 yr. Mean DMR	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58



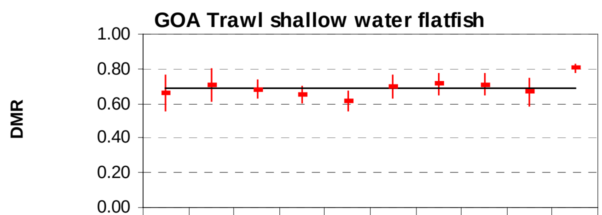
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
No. vessels	46	41	31	12	11	33	21	22	31	16
Annual DMR	0.51	0.62	0.66	0.57	0.48	0.66	0.79	0.66	0.55	0.55
10 yr. Mean DMR	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61



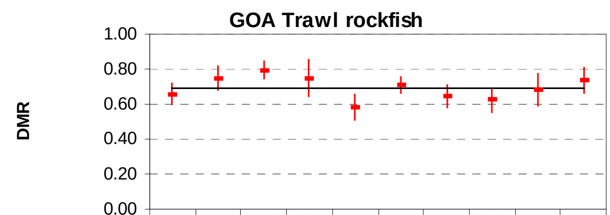
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
No. vessels	82	85	81	60	43	74	70	63	64	55
Annual DMR	0.60	0.62	0.66	0.59	0.53	0.65	0.68	0.62	0.64	0.54
10 yr. Mean DMR	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61



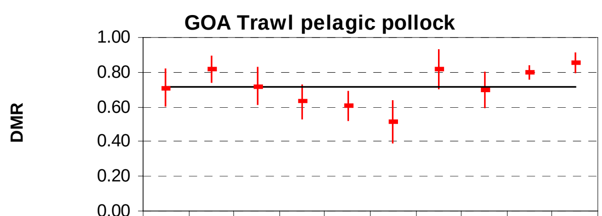
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
No. vessels	24	32	29	37	9	13	8	15	9	10
Annual DMR	0.61	0.58	0.70	0.59	0.62	0.56	0.71	0.61	0.51	0.51
10 yr. Mean DMR	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60



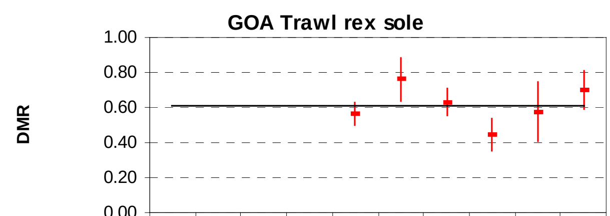
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
No. vessels	17	9	17	22	21	23	30	25	25	6
Annual DMR	0.66	0.71	0.68	0.65	0.62	0.70	0.71	0.71	0.67	0.81
10 yr. mean DMR	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
No. vessels	27	25	24	17	19	26	30	33	30	34
Annual DMR	0.66	0.75	0.79	0.75	0.58	0.71	0.64	0.63	0.68	0.74
10 yr. Mean DMR	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69

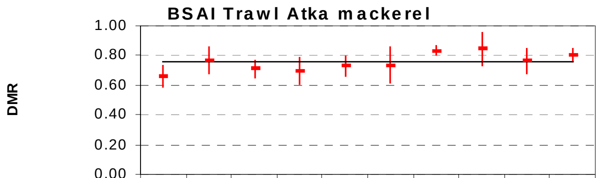


	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
No. vessels	20	36	23	30	31	40	16	33	50	33
Annual DMR	0.71	0.82	0.72	0.63	0.61	0.51	0.82	0.70	0.80	0.86
10 yr. Mean DMR	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72

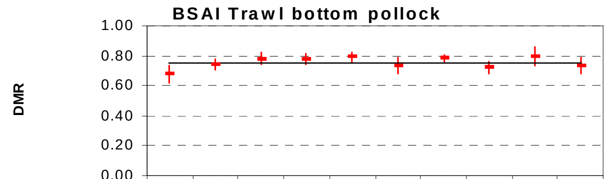


	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
No. vessels					11	13	15	6	7	9
Annual DMR					0.56	0.76	0.63	0.45	0.58	0.70
10 yr. Mean DMR	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61

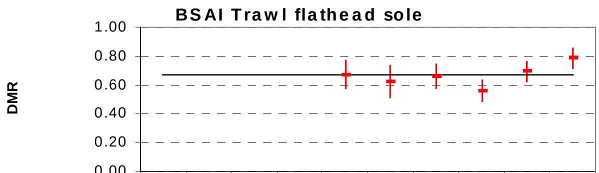
Figure 1. **Plots of the historical trend in halibut discard mortality rates for Gulf of Alaska trawl fisheries. Data points indicate mean annual DMR ± standard error. Also shown is the 10-year mean DMR.**



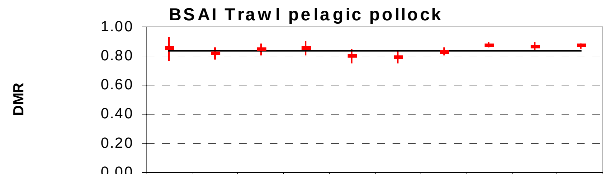
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
No. vessels	21	31	28	19	10	11	15	8	12	15
Annual DMR	0.66	0.77	0.71	0.70	0.73	0.74	0.83	0.84	0.77	0.81
10 yr. Mean DMR	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75



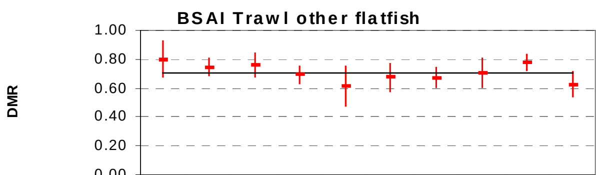
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
No. vessels	75	93	107	89	85	71	111	113	91	72
Annual DMR	0.68	0.74	0.78	0.78	0.80	0.74	0.79	0.72	0.80	0.74
10 yr. Mean DMR	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76



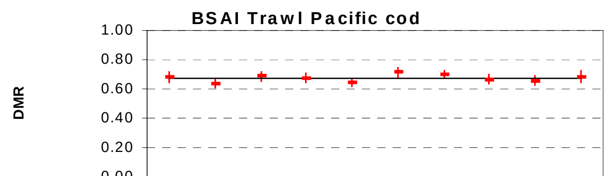
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
No. vessels					8	11	14	13	21	19
Annual DMR					0.67	0.62	0.66	0.56	0.70	0.79
10 yr. Mean DMR	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67



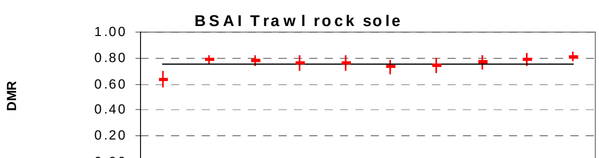
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
No. vessels	59	81	81	56	80	87	95	95	83	68
Annual DMR	0.85	0.82	0.85	0.85	0.80	0.79	0.83	0.87	0.87	0.87
10 yr. Mean DMR	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84



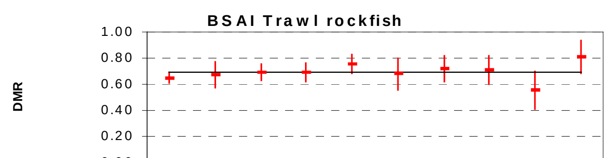
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
No. vessels	21	42	28	28	9	16	14	25	26	20
Annual DMR	0.80	0.75	0.76	0.69	0.61	0.68	0.67	0.71	0.78	0.63
10 yr. Mean DMR	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71



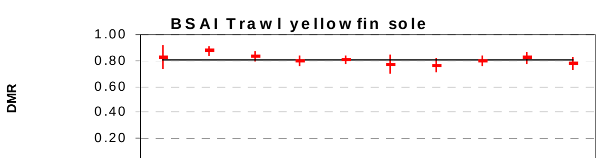
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
No. vessels	69	103	79	86	75	93	116	93	94	77
Annual DMR	0.68	0.64	0.69	0.67	0.64	0.71	0.70	0.67	0.66	0.69
10 yr. Mean DMR	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67



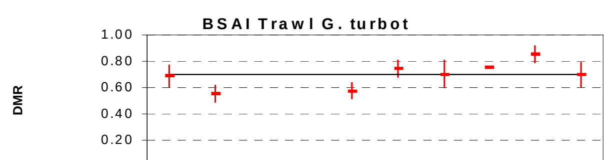
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
No. vessels	26	49	45	38	29	41	36	38	27	22
Annual DMR	0.64	0.79	0.78	0.76	0.77	0.73	0.74	0.77	0.79	0.81
10 yr. Mean DMR	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
No. vessels	26	19	26	18	8	5	10	7	5	11
Annual DMR	0.65	0.67	0.69	0.69	0.75	0.68	0.72	0.71	0.56	0.81
10 yr. Mean DMR	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69

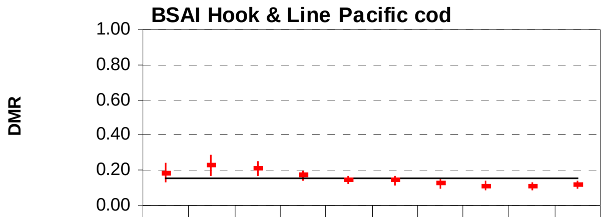


	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
No. vessels	20	48	49	26	36	44	35	35	27	26
Annual DMR	0.83	0.88	0.83	0.80	0.81	0.77	0.76	0.80	0.82	0.78
10 yr. Mean DMR	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81

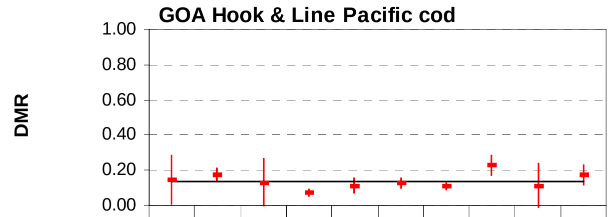


	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
No. vessels	20	28			16	37	4	3	3	8
Annual DMR	0.69	0.55			0.58	0.75	0.70	0.75	0.86	0.70
10 yr. Mean DMR	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70

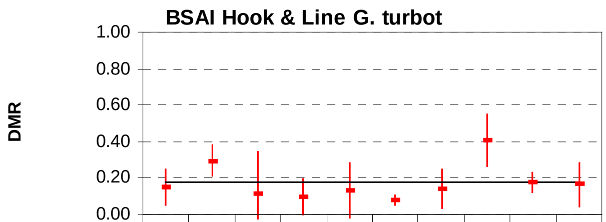
Figure 2. Plots of the historical trend in halibut discard mortality rates for Bering Sea/Aleutians trawl fisheries. Data points indicate mean annual DMR ± standard error. Also shown is the 10-year mean DMR.



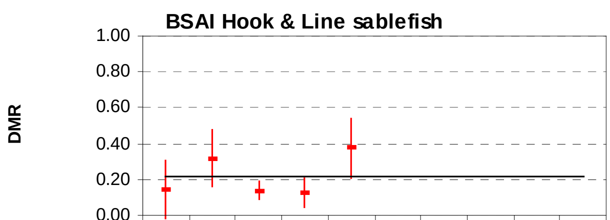
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
No. vessels	32	45	44	42	40	36	37	37	39	38
Annual DMR	0.19	0.23	0.21	0.17	0.15	0.15	0.12	0.11	0.11	0.12
10 yr. mean DMR	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16



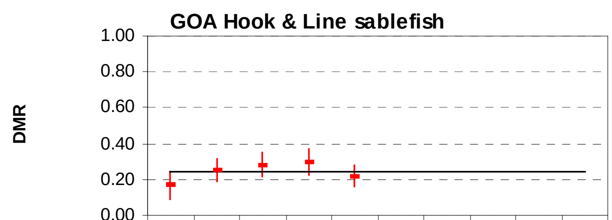
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
No. vessels	10	13	21	10	10	16	9	6	9	15
Annual DMR	0.15	0.18	0.13	0.07	0.11	0.13	0.11	0.23	0.11	0.17
10 yr. Mean DMR	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14



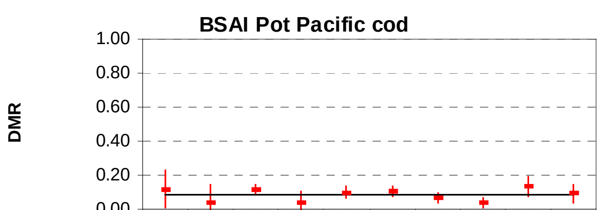
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
No. vessels	12	15	12	20	10	15	12	12	20	9
Annual DMR	0.15	0.30	0.11	0.10	0.14	0.08	0.14	0.41	0.18	0.17
10 yr. Mean DMR	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18



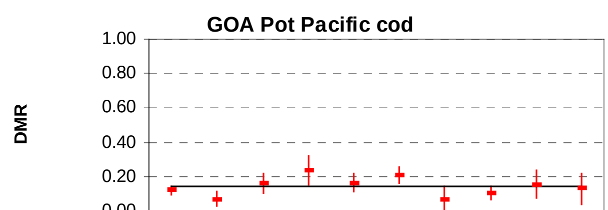
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
No. vessels	11	10	4	9	7					
Annual DMR	0.14	0.32	0.14	0.13	0.38					
10 yr. Mean DMR	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
No. vessels	46	48	43	37	19					
Annual DMR	0.17	0.25	0.28	0.30	0.22					
10 yr. mean DMR	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24

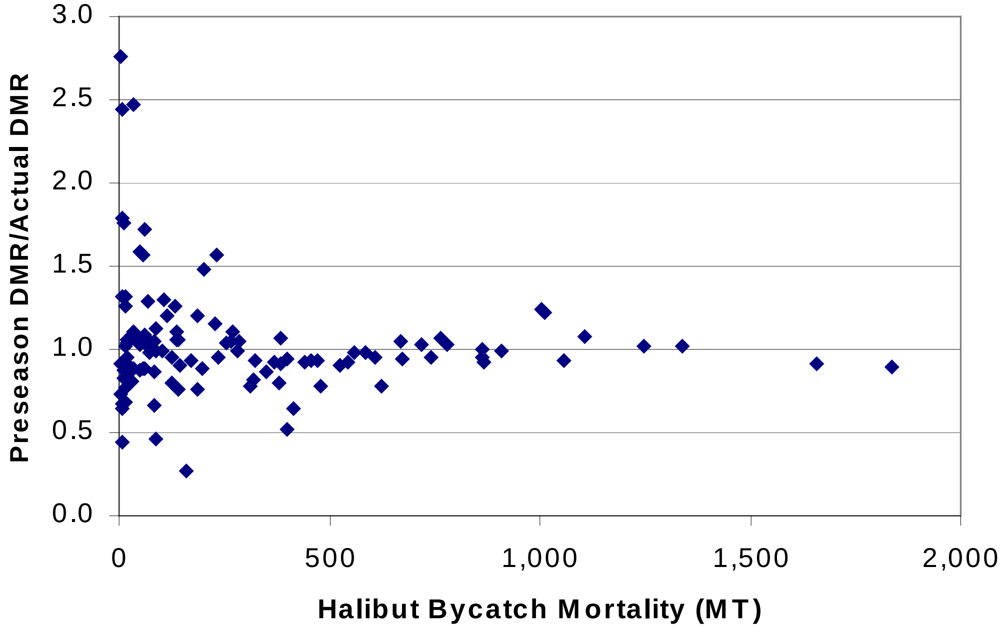


	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
No. vessels	7	14	38	10	25	45	73	45	42	68
Annual DMR	0.12	0.04	0.12	0.04	0.10	0.10	0.07	0.04	0.13	0.09
10 yr. mean DMR	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
No. vessels	14	19	49	16	10	37	28	10	22	33
Annual DMR	0.12	0.07	0.16	0.24	0.17	0.21	0.07	0.11	0.16	0.13
10 yr. mean DMR	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14

Figure 3. **Plots of the historical trend in halibut discard mortality rates for Bering Sea/Aleutians (BSAI) and Gulf of Alaska (GOA) fixed gear fisheries. Data points indicate mean annual DMR ± standard error. The 10-year mean is also shown.**



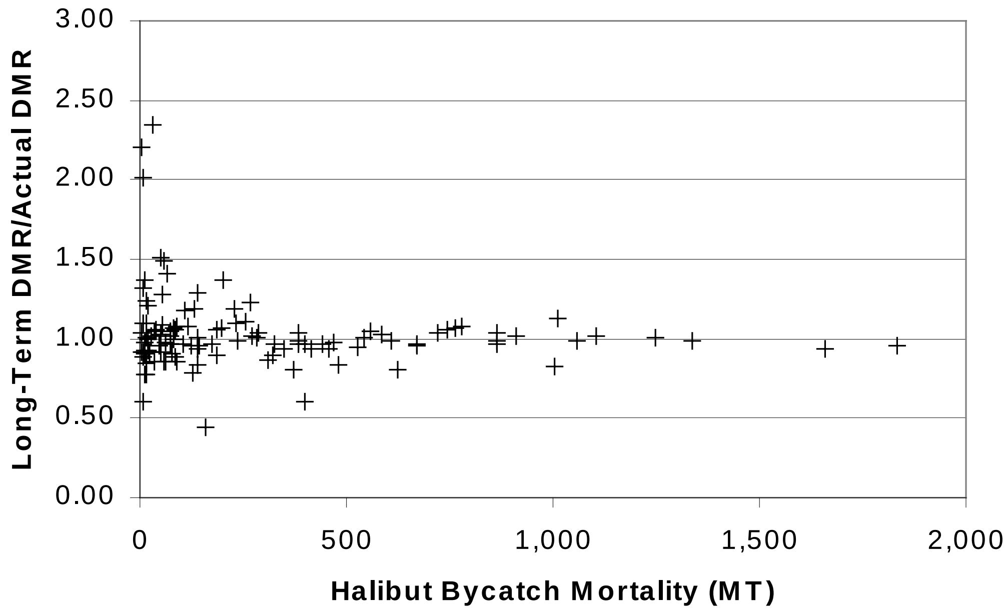


Figure 4. Distributions of the bycatch mortality ratios using the preseason assumed and long-term sets of DMRs to estimate bycatch mortality.

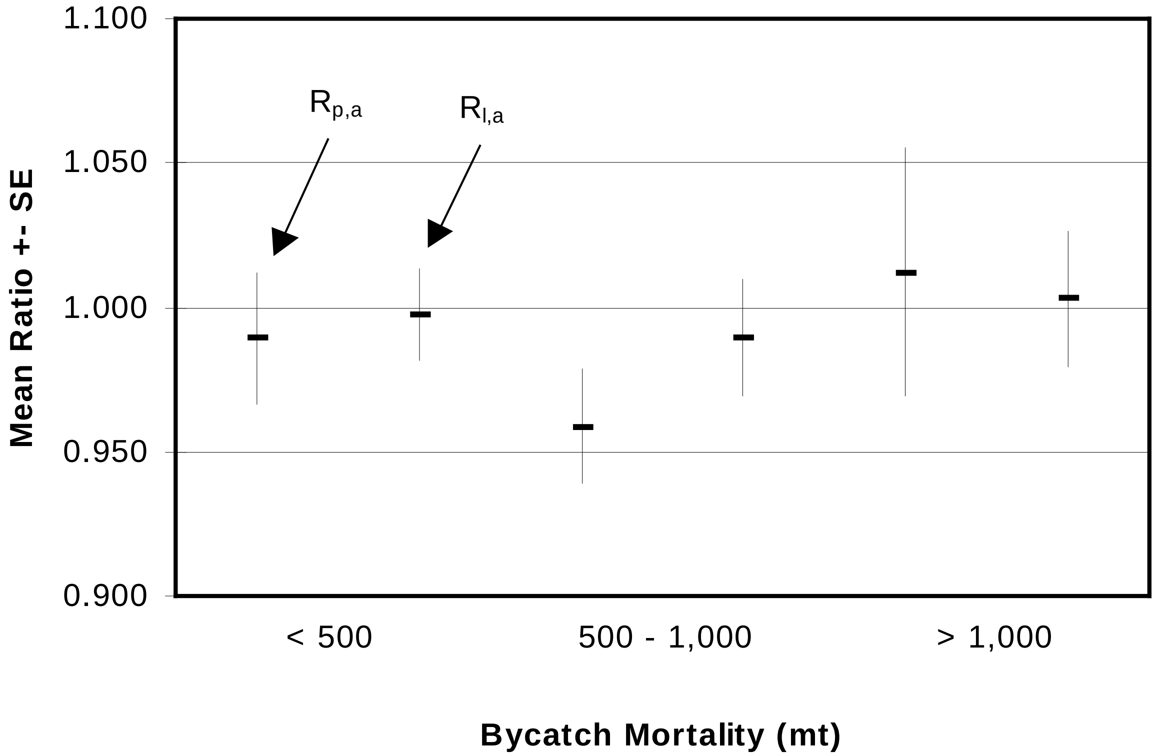


Figure 5. **Mean of the ratios of (1) estimated bycatch mortality based on preseason assumed DMRs to bycatch mortality from actual DMRs ($R_{p,a}$) and (2) bycatch mortality based on 10-year average DMRs to bycatch mortality from actual DMRs ($R_{l,a}$) for three strata of mortality. Error bars represent standard error.**